Cloud Microstructure via the
Fast Time-Resolved Aerosol Collector
Fast TRAC…….
…with Holographic Imaging

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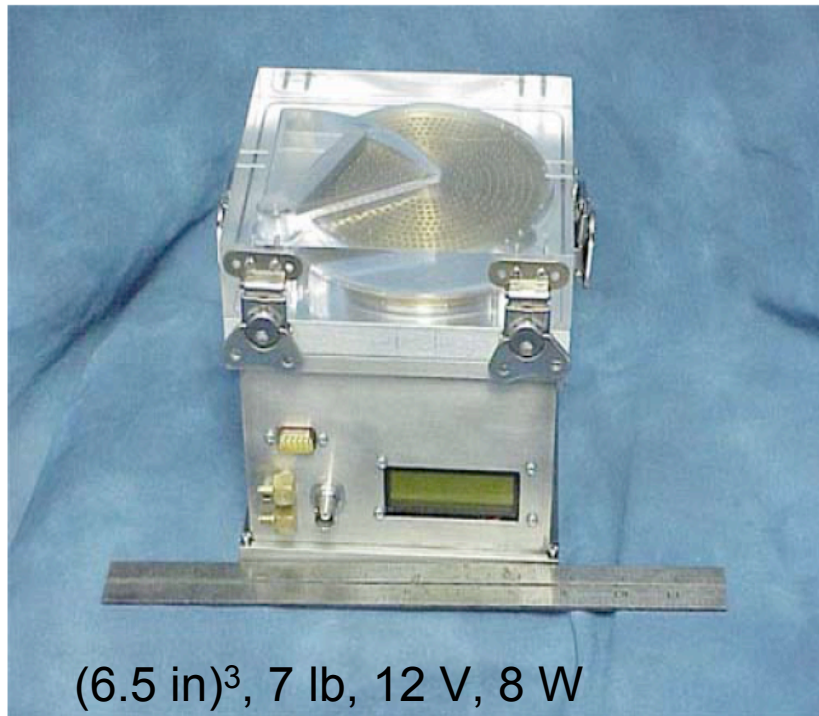
Cloud Microstructures ≤ 1 m

Want to know the aerosols at this resolution

Aircraft flies at 150 m/s
Need time resolution 1 m/150 m/s
= 6 ms (!!!!!)

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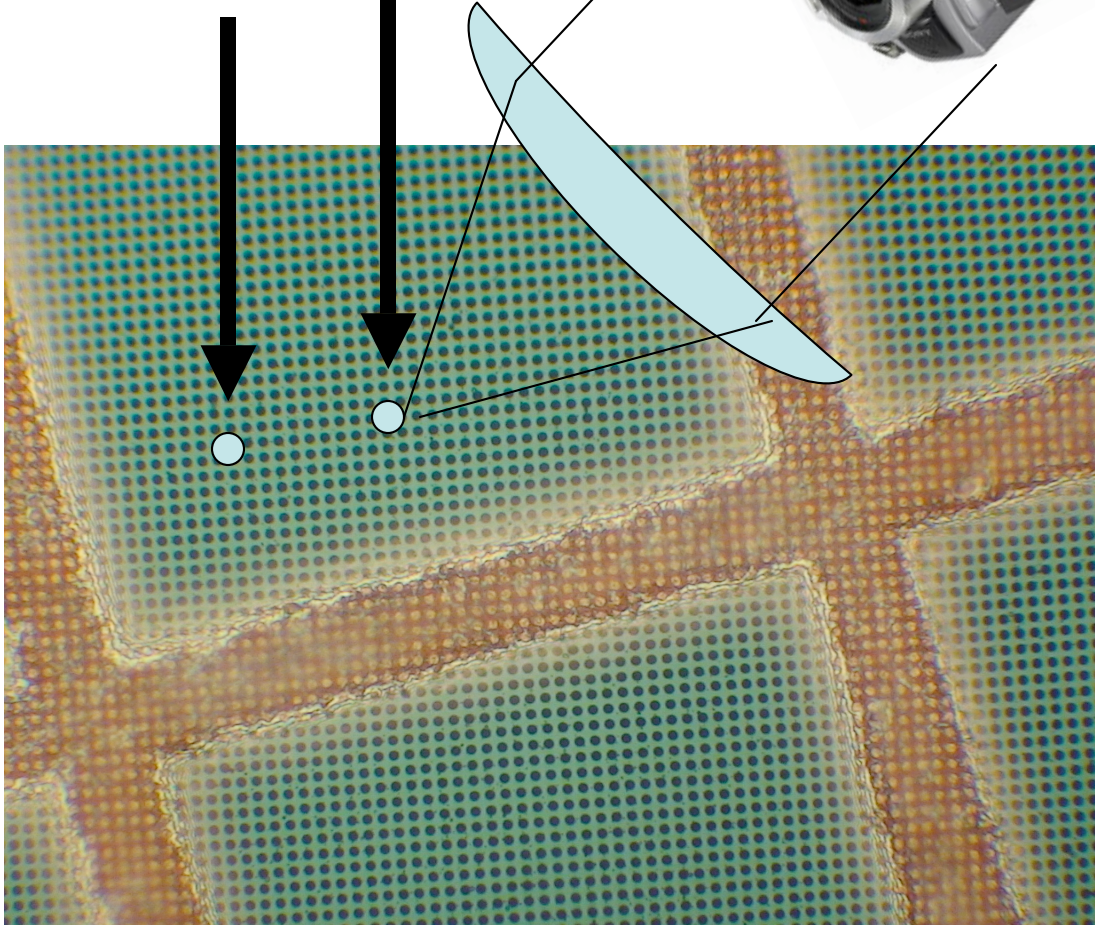
What is TRAC? - Time-Resolved Aerosol Collector

(6.5 in)^3, 7 lb, 12 V, 8 W

- Uses an impactor
- ~ 600 TEM samples
- Flow rate: 1 l/min
- Time resolution: ≥ 1 min*
- Applications: Off-line analysis:
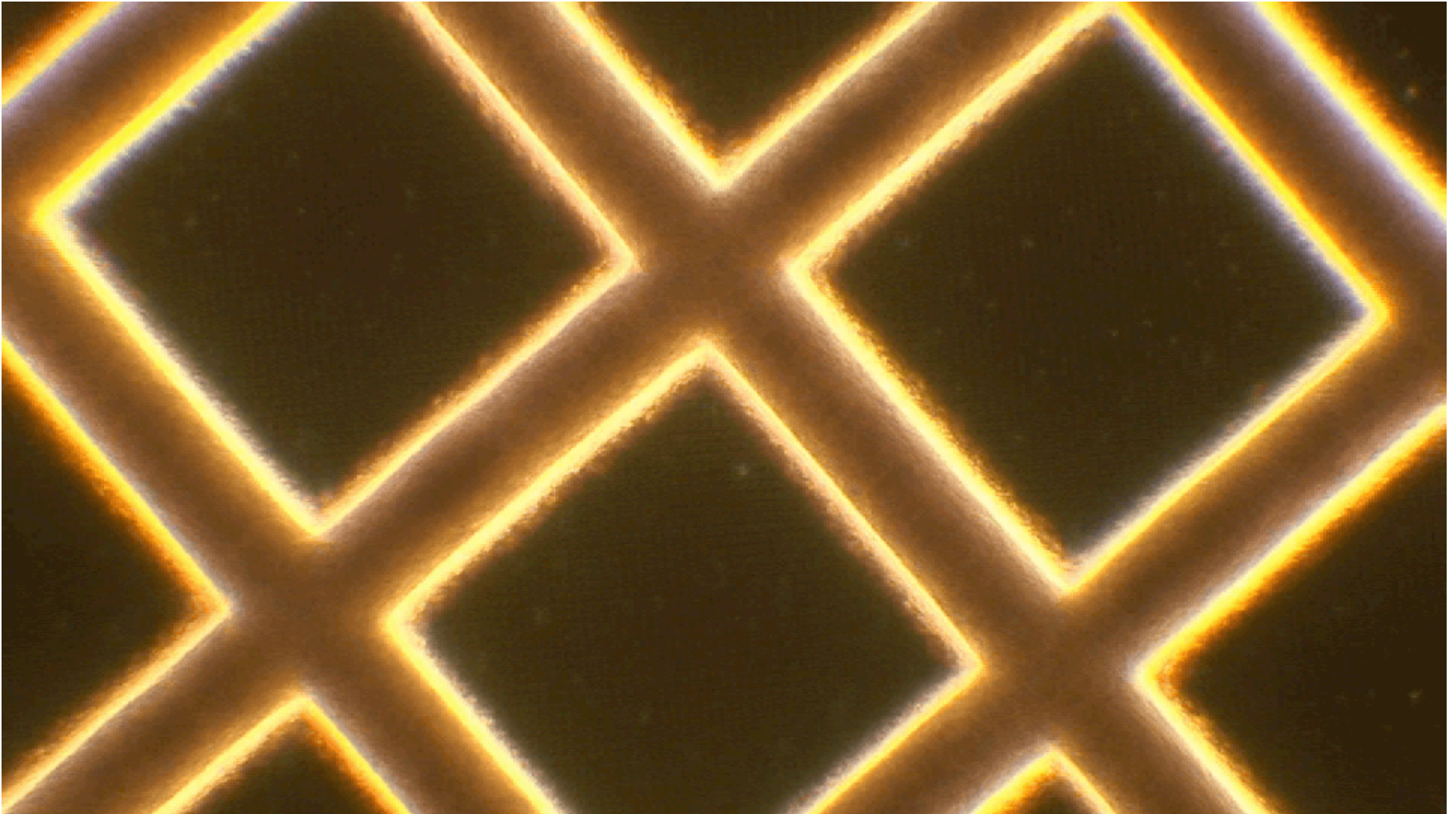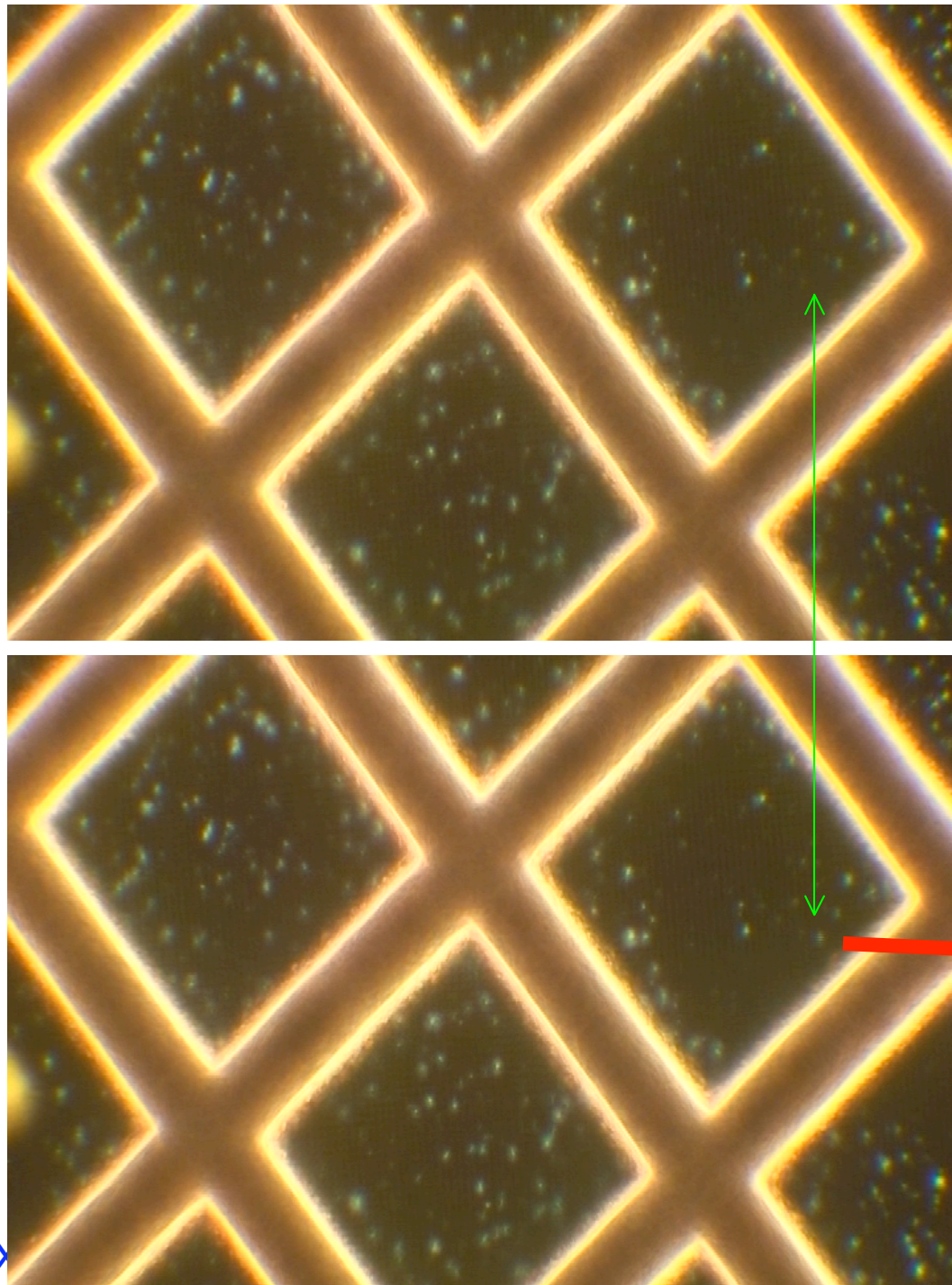 - particle hygroscopicity, morphology, composition..
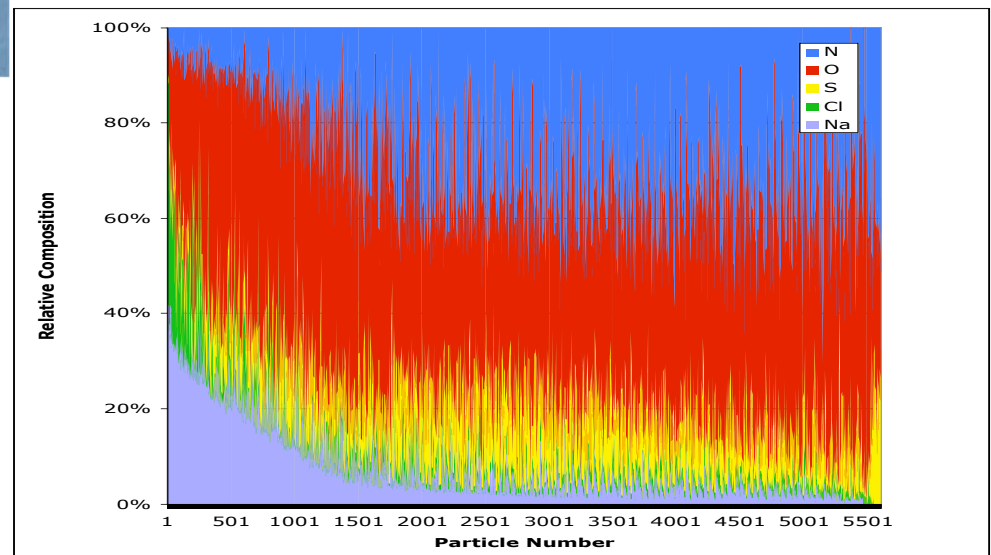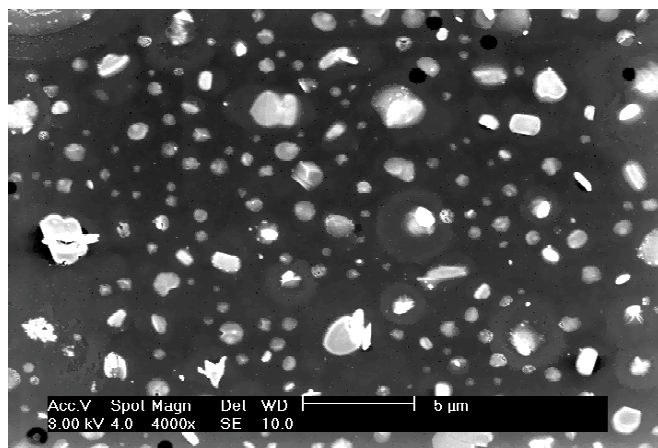
Fast TRAC Solution

- Observe the particles DURING their collection with video microscope

- See ≥ 100 nm particles
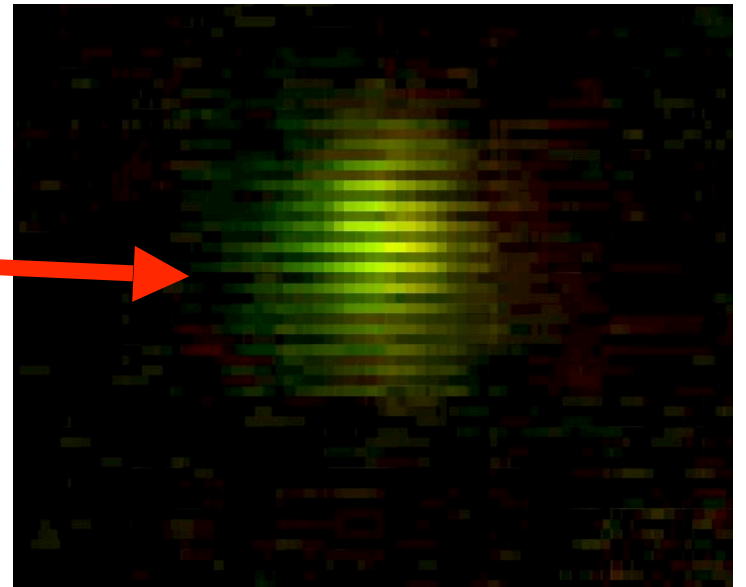
- ~4 ms time resolution

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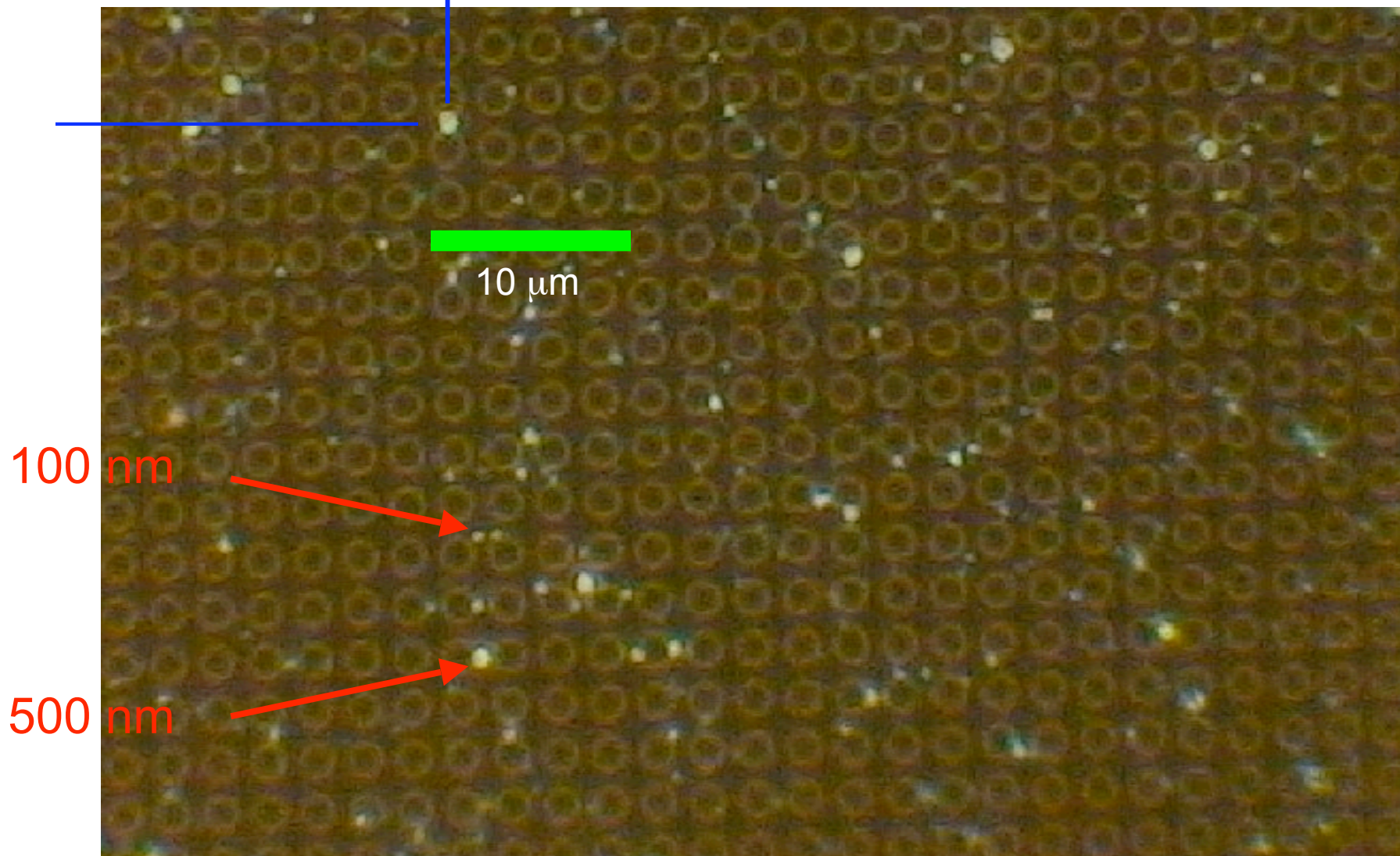
Results - movies of 200 nm lab particles

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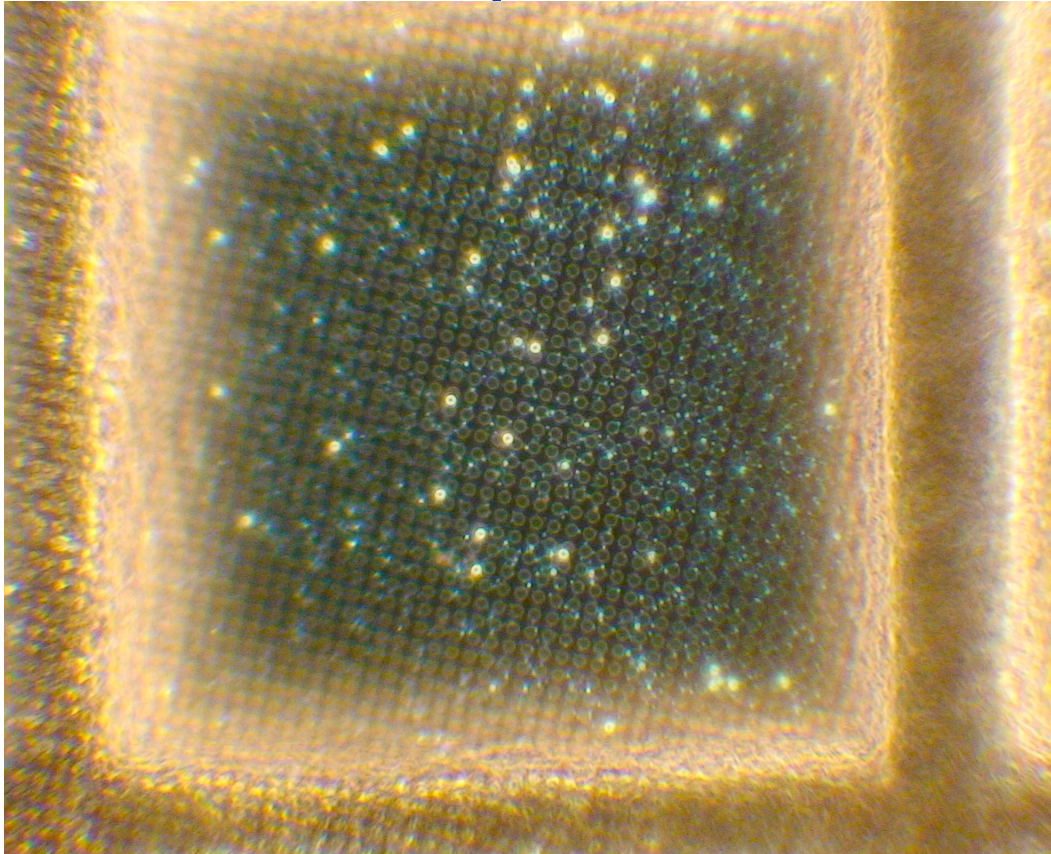Difference photo is black except for diffraction-limited image of 200 nm particle

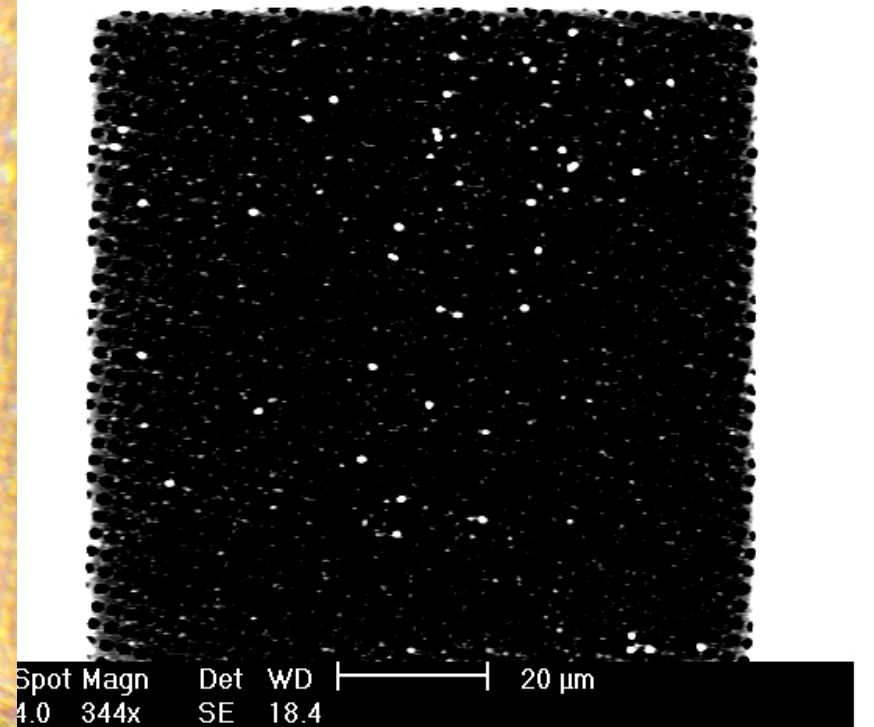# Particle locations to +/- 0.1 micron

10 μm

100 nm

500 nm

Real-time Optical Sizing !!!!

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Optical and STEM Photos

Optical particle map and times

SEM/EDX map and elemental analysis

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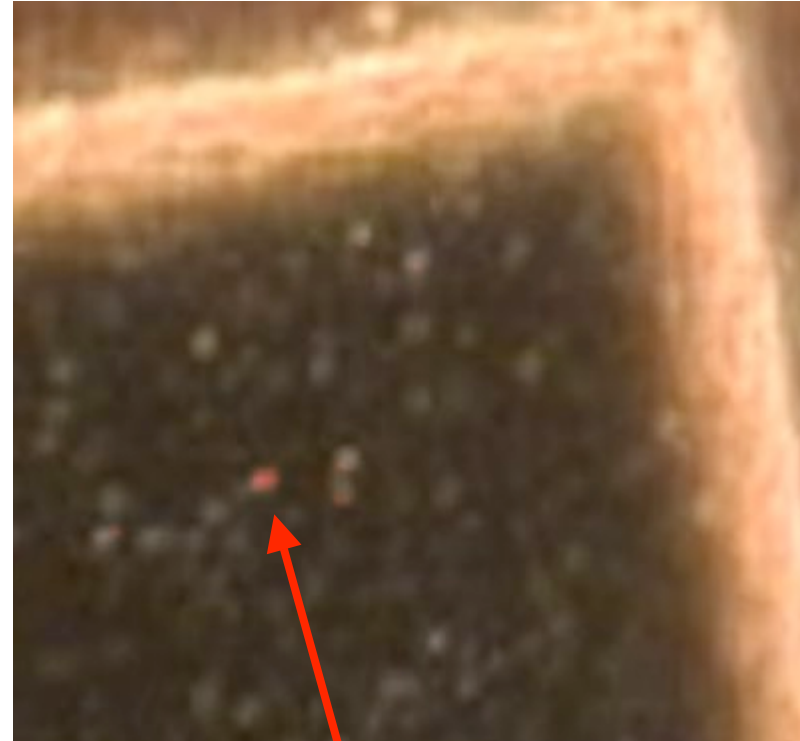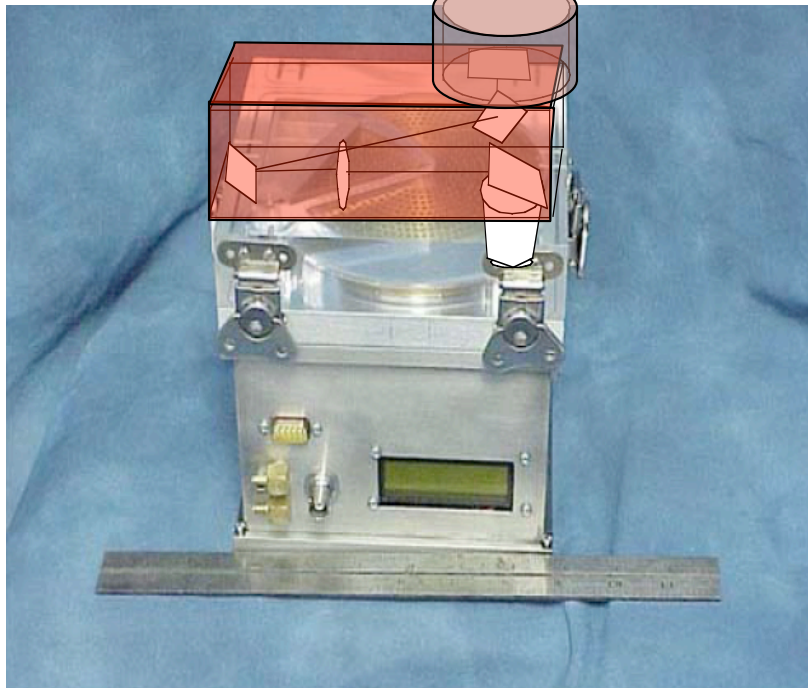
Fast Framing
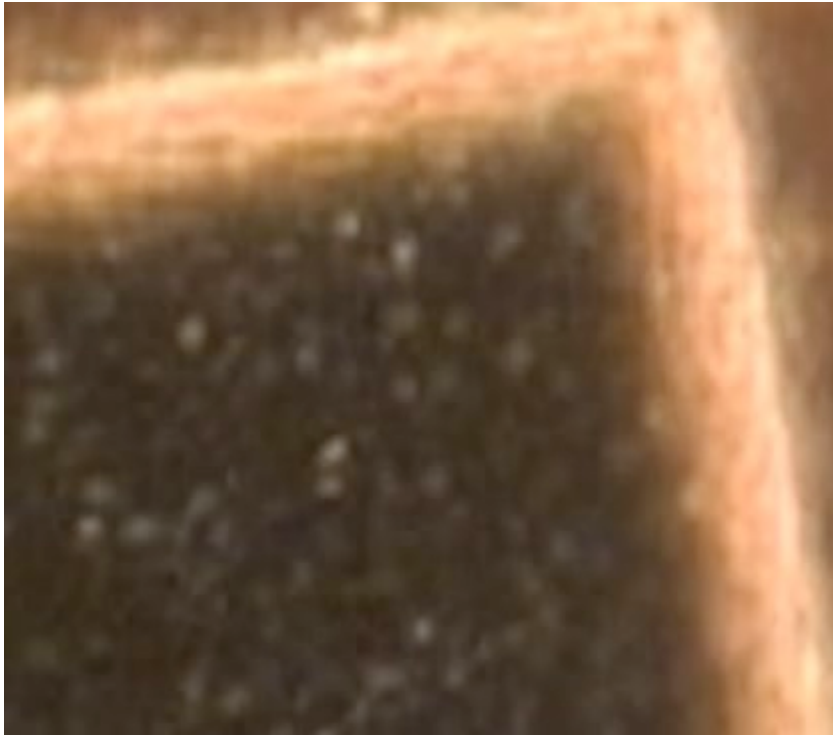
Frame 153

Frame 154

New 100 nm
Particle Arrives

- 240 frames/sec
- 4 ms per frame
- See ≥ 100 nm particles arriving

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Fast TRAC Features

Size of new Fast-TRAC

- Real-time particle optical sizing
- 4 ms time resolution
- Extensive off-line analyses
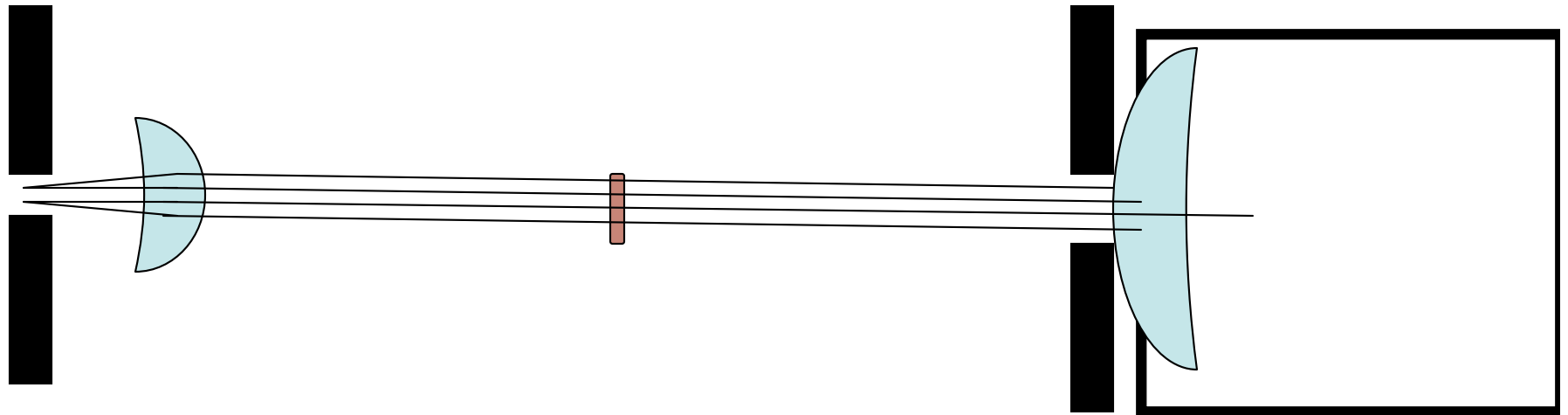- **Good for cloud microstructures**
- **And plumes**

We need longer depth of field….

Substrates not always perfectly flat
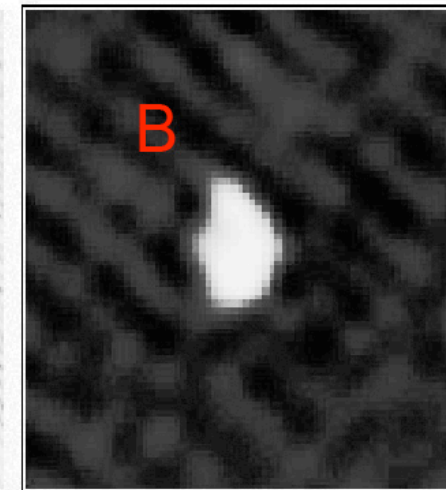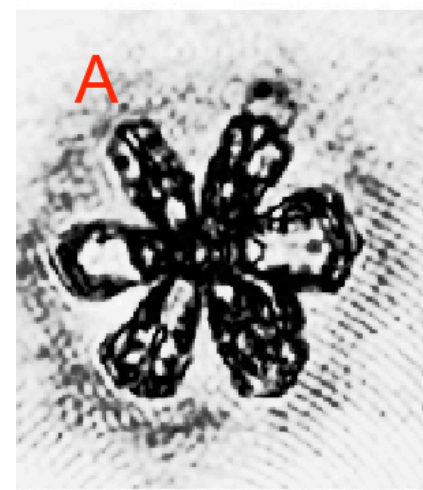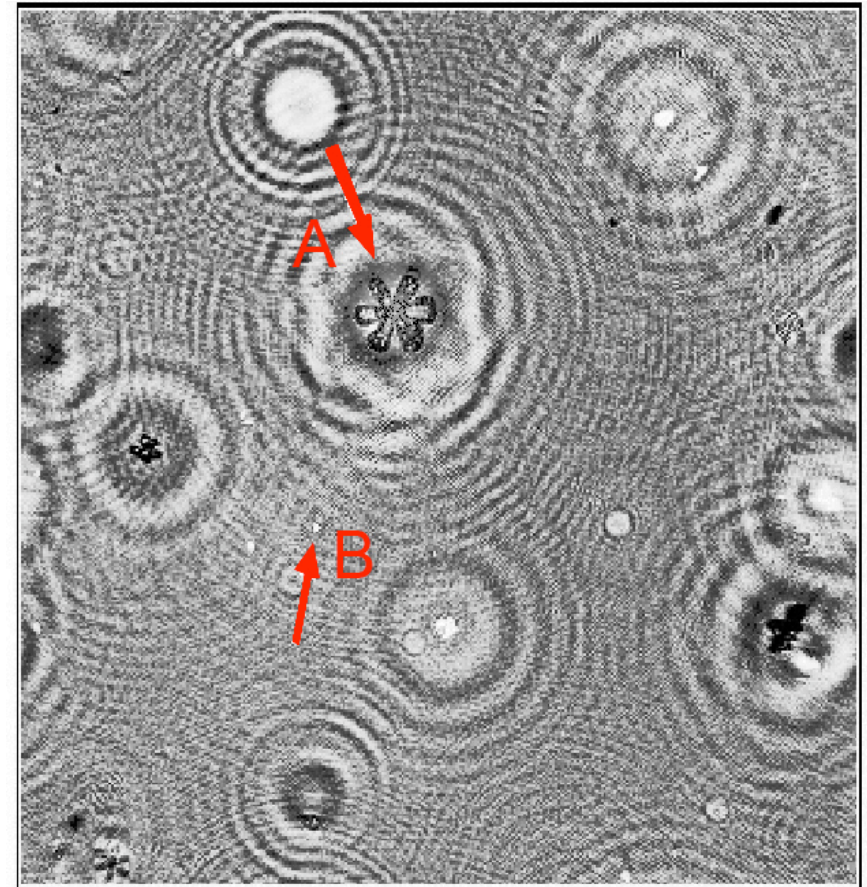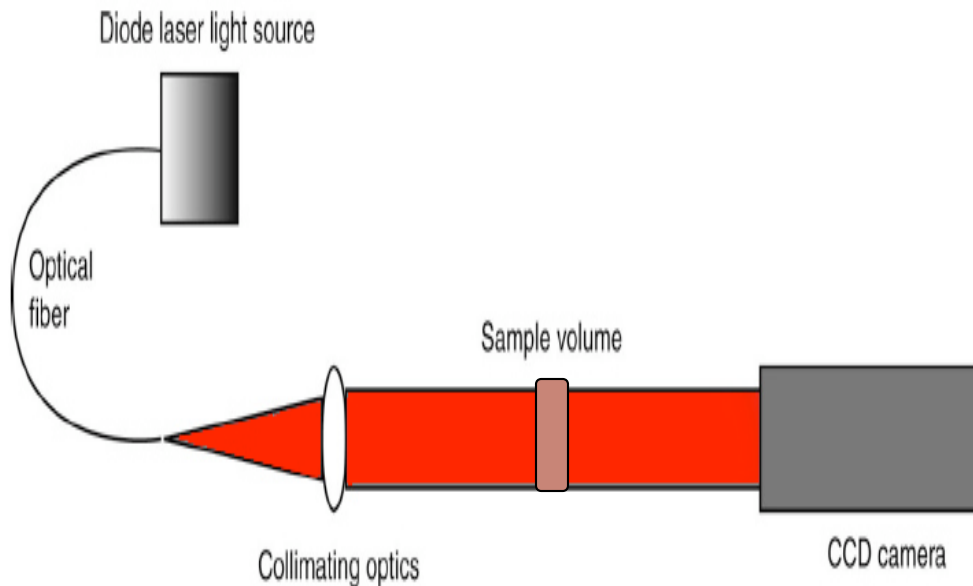
Severe vibrations may shift , flex film

To my surprise, imaging works well in brightfield illumination too, even for 100 nm particles…

1) Improve depth of field by incoherent well collimated brightfield illumination

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2) Improve depth of field by post processing for coherent holographic brightfield illumination

…as used in some snowflake imagers, undersea imagers

Diode laser light source

Optical fiber

Collimating optics

Sample volume

CCD camera

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Future Work

- Make it field-portable

- Deploy Fast TRAC in field campaigns

- Collaborations

PNNL's Fast TRAC for cloud microstructures and plumes

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